REMARKS / ARGUMENTS

Summary of the Present Invention

The present invention is a modification of the Houdry process for the dehydrogenation of aliphatic hydrocarbons, whereby the cycle is extended, or lengthened, and hydrogen recycle is added to the feed. The combination of the extended cycle with the hydrogen recycle results in a surprising stabilization of the production rate in the dehydrogenation process.

Remarks Regarding Claims Rejected Under 35 USC §112

The Examiner has rejected claim 13 under 35 U.S.C. §112, second paragraph for including the trademark / tradename Catofin®. However, this mark appears only in Claim 12 so Applicant has made the assumption that the Examiner intended to refer to Claim 12 instead of Claim 13. In response, Applicant has canceled Claim 12 from the application.

Remarks Regarding Claims Rejected Under 35 USC §103(a)

The Examiner has rejected Claims 1 – 20 under 35 U.S.C §103(a) as obvious in view of Houdry (U.S. Patent 2,419,997, "the '997 patent") and Herbstman (U.S. Patent 4,409,417, "the '417 patent").

The '997 patent teaches and claims a cyclic operation for the catalytic dehydrogenation of aliphatic hydrocarbons. Specifically, the Houdry process includes a series of stages wherein the catalyst bed is evacuated, reduced with hydrogen and evacuated, then an aliphatic hydrocarbon is introduced and dehydrogenated, then the catalyst bed is steam purged and regenerated, and the cycle is repeated starting with the reduction stage. The '997 patent teaches that, for the catalytic dehydrogenation process to be commercially useful, the contact time or cycle time must be carefully controlled and must be shorter than at perfect adiabatic balance to reduce the risk of temperature run-away. (See Column 1, lines 35 – 50; column 2, lines 28 – 35; column 2, line 6 – column 3, line 2) Houdry notes that, alternatively, the longer contact time may be used, but then it is necessary to hold the temperature lower than at adiabatic balance, and this reduces olefin yield. (See column 3, lines 2 – 5.) The '997 patent does not teach or suggest that the reaction cycle time, including the contact time, can be increased without reducing the temperature of the catalyst bed. Nor does the '997 patent teach or suggest that hydrogen can be added to the catalyst bed with the hydrocarbon that is to be dehydrogenated.

The '417 patent teaches and claims a dehydrogenation process wherein hydrogen is added to the catalyst bed with ammonia and the hydrocarbon that is to be dehydrogenated. The hydrogen serves as a diluent and lowers the partial pressure of the dehydrogenatable hydrocarbon while suppressing the formation of hydrogen-deficient carbonaceous deposits on the catalyst composite. (See column 4, lines 8 – 17.) The '417 patent does not teach or suggest that hydrogen can be added to the dehydrogenation reaction without the simultaneous addition of ammonia. Nor does the '417 patent teach or suggest that the reaction cycle time, including the contact time, can be increased without reducing the temperature of the catalyst bed.

In the present development, independent claims 1, 13 and 18 require that a delay be added to the normal Houdry cycle and that hydrogen be added to the dehydrogenation stage of the Houdry cycle. The modified Houdry cycle resulting from the combination of the extended cycle with the hydrogen recycle results in a surprising stabilization of the production rate in the dehydrogenation process.

Because the Houdry cycle relies on multiple reactors designed to function in tandem, a modification in the timing for the reaction in the first set of reactors automatically results in a change in the timing in the other reactors; and a delay in one set of reactors would then necessarily increase the contact time between the catalyst and the hydrocarbon being dehydrogenated – opposite to the teaching of Houdry. Supposedly, any risk of run-away could be reduced by adjusting the reaction conditions such that the catalyst bed temperature was decreased relative to the catalyst bed of the standard Houdry dehydrogenation process. (See the '997 patent at column 3, lines 2 – 5.) But, as noted in the present application at page 4, line 25 – page 5, line 8, there is a noted *increase* in the temperature change of the catalyst bed when the extended cycle time is used relative to the temperature change of the catalyst bed without the extended cycle time. Even with this temperature change increase, when the extended cycle time is combined with the introduction of hydrogen in the dehydrogenation stage, surprisingly run-away does not occur. Thus, the claims of the present application are distinguishable from the teachings of the '997 patent.

With respect to the '417 patent, Applicant does not dispute that hydrogen has been added to dehydrogenation reactions in the prior art to reduce the coke make. However, the addition of hydrogen with the hydrocarbon to be dehydrogenated would not be expected to affect the cycle time in a Houdry dehydrogenation reaction – as is required by independent claims 1, 13 and 18 of the present application – and the '417 patent does not teach or suggest that the cycle times should

be extended in the dehydrogenation process when hydrogen is added. Thus, the claims of the present application are distinguishable from the teachings of the '417 patent.

It is worth noting that the '997 patent was issued in 1943, and generally became known as the Houdry dehydrogenation process. By increasing the cycle time in combination with adding the hydrogen recycle to the dehydrogenation stage, unexpected results were obtained in the form of stabilization of the production rate in the dehydrogenation process. Moreover, it is generally known in the art that when hydrogen is added to the dehydrogenation reaction, a less favorable equilibrium toward dehydrogenation is created and so the yield normally decreases – an unacceptable result that is *not* observed when the addition of hydrogen is combined with the increased cycle time. Finally, for at least the past three years, the Applicant has demonstrated commercial benefits of using this modified process in the form of decreased rates of loss of functionality of the catalyst, thereby increasing the catalyst lifetime and, improving the activity and selectivity of the catalyst, thereby maintaining yield of the desired olefins.

Remarks Regarding Allowable Subject Matter

The Examiner has not indicated that any claims would be allowable if rewritten or amended to overcome the rejections under 35 U.S.C. 112, second paragraph.

Remarks Regarding Citations

Applicant has made note of the prior art recited by the Examiner in the Notice of References Cited.

Claims 1 – 11 and 13 – 20 remain in the present application. Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

Respectfully submitted,

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